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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/509,371	05/27/2005	Takuya Sugawara	101249.55458US	3837
23911 7590 03/27/2007 CROWELL & MORING LLP INTELLECTUAL PROPERTY GROUP P.O. BOX 14300 WASHINGTON, DC 20044-4300			EXAMINER LEE, CHEUNG	
			ART UNIT 2812	PAPER NUMBER
SHORTENED STATUTORY PERIOD OF RESPONSE		MAIL DATE	DELIVERY MODE	
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Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary

Application No.

10/509,371

Applicant(s)

SUGAWARA ET AL.

Examiner

Cheung Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 December 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-54 is/are pending in the application.
- 4a) Of the above claim(s) 6,7 and 45 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 42-44 is/are allowed.
- 6) ☒ Claim(s) 1-5,8-39,41,46-49 and 51-54 is/are rejected.
- 7) ☒ Claim(s) 40 and 50 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

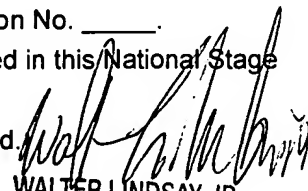
Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.


WALTER LINDSAY JR.
PRIMARY EXAMINER

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 6-23-06.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____.

DETAILED ACTION

Notice to Applicant

1. Applicants' Amendment and Response to the Office Action mailed on March 23, 2006 has been entered and made of record.

Election/Restrictions

2. Applicants' election of Group I, claims 1-5, 8-44 and 46-54, in the reply filed on December 15, 2006 is acknowledged. Because applicants did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on June 23, 2006 was filed after the mailing date of the first action on March 23, 2006. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Response to Amendment

4. In view of applicants' amendments and arguments filed on August 23, 2006, the rejections of claims 1-5 under 35 U.S.C. 103(a) as stated in the Office Action mailed on March 23, 2006 have been withdrawn. Applicants' arguments have been rendered moot in view of the new or modified ground of rejection given below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1 and 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murakawa et al. (JP 2000-294550; hereinafter "Murakawa") in view of Bloom et al. (US Pat. 6228779; hereinafter "Bloom").

6. Referring to figures 1-7 and related text, Murakawa discloses [Re claim 1] a process for forming an underlying film, comprising: irradiating the surface of an electronic device substrate 1 with plasma based on a process gas (paragraph 29) comprising at least an oxygen atom-containing gas (paragraphs 16 and 29), to thereby

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form an underlying film 21 on the electronic device substrate, but Murakawa fails to disclose expressly wherein irradiating the surface of an insulating film 22 disposed on the substrate, to thereby form the underlying film at the interface between the insulating film and the electronic device substrate.

Referring to figures 1-2 and related text, Bloom discloses wherein forming a gate dielectric 20 on a substrate 10, which contains [Re claim 4] a silicon dioxide layer as an underlying layer and a silicon nitride layer as an insulating layer. The silicon dioxide layer is formed at the interface between the silicon nitride and the substrate (col. 3, lines 5-30).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the formation of an underlying film between an insulating film and a substrate, as taught by Bloom, because it would have been to enhance process control for growing ultra thin silicon dioxide film (Bloom, col. 3, lines 39-45), and to obtain a dielectric film with less oxygen vacancies and less impurities showing superior film properties.

7. Murakawa discloses [Re claim 5] wherein the plasma is generated based on a plane antenna member (RLSA) (paragraph 24; see abstract).

8. Claims 3, 8 and 11-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murakawa in view of Bloom, as applied above, and further in view of Suzuki et al. (US Pat. 6497783; hereinafter "Suzuki").

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9. Murakawa discloses [Re claim 3] a plasma containing oxygen (paragraph 29), but Murakawa fails to disclose expressly wherein a plasma containing oxygen radical.

Suzuki discloses radicals of the plasma from processing gas, which are used to process a wafer (col. 29, lines 40-45).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use oxygen radicals of the plasma, as taught by Suzuki, because it would have been to obtain better oxidation at low temperature, and to form an uniform oxide layer.

10. [Re claim 8] The combined teaching of Murakawa and Bloom discloses substantially the claimed limitations, as shown in claim 1, but it fails to disclose expressly wherein converting the oxygen atom-containing gas to thereby generate oxygen radicals, and irradiating with the oxygen radicals.

Suzuki discloses radicals of the plasma from processing gas, which are used to process a wafer (col. 29, lines 40-45). The motivations stated in claims 1 and 3 also apply.

11. Murakawa discloses [Re claim 11] wherein the process gas comprises at least one rare gas selected from the group consisting of Kr, Ar, He and Xe (paragraph 19).

12. Murakawa discloses [Re claim 12] wherein the oxygen atom-containing gas is O₂ gas (paragraph 62).

13. Claims 9-10 and 13-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combined teaching of Murakawa, Bloom and Suzuki, as applied

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above, and further in view of Deboer et al. (US Pub. 2001/0036752; hereinafter "Deboer").

14. [Re claim 9] The combined teaching of Murakawa, Bloom and Suzuki fails to disclose expressly wherein the insulating film comprises a high-dielectric constant material.

Referring to figure 1 and related text, Deboer discloses a high dielectric film 14 as an insulating film (page 2, paragraph 21), [Re claim 10] which includes HfO_2 , Ta_2O_5 , etc. (page 1, paragraph 9; page 2, paragraph 21).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use a high dielectric constant film, as taught by Deboer, because it would have been to achieve a larger capacitance value in a smaller area (Deboer, page 1, paragraph 3).

15. [Re claim 13] The combined teaching of Murakawa, Bloom and Suzuki fails to disclose expressly wherein further comprising annealing the substrate after the formation of the oxide film.

Deboer discloses a post-deposition anneals after formation of a dielectric film using O_2 as a source gas (page 2, paragraph 21). [Re claim 14] The post-deposition anneal is performed in an oxygen ambient (page 2, paragraph 21), and the oxygen source can be provided using O_2 (page 4, paragraph 34).

Since Bloom discloses the silicon dioxide is formed in an oxygen atmosphere of O_2 (col. 3, lines 20-25), so the post-deposition anneal may perform.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to perform a post-deposition anneal, as taught by Deboer, because it would have been to eliminate oxygen vacancies reducing leakage current (Deboer, page 2, paragraph 21).

16. Deboer discloses [Re claim 15] wherein the annealing is conducted at a temperature of 500-1100°C (page 4, paragraph 34). In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

17. Claims 2, 16-28, 46-49 and 51-54 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combined teaching of Murakawa and Bloom, as applied above, and further in view of Deboer.

18. [Re claim 2] The combined teaching of Murakawa and Bloom fails to disclose expressly wherein the insulating film comprises a high-dielectric constant material.

Referring to figure 1 and related text, Deboer discloses a high dielectric film 14 as an insulating film (page 2, paragraph 21). The motivation stated in claim 9 also applies.

19. Referring to figures 1-7 and related text, Murakawa discloses [Re claim 16] a process for forming an insulating film, comprising: forming an insulating film 22 on a substrate 1, generating plasma based on a process gas (paragraph 29) comprising at least an oxygen atom-containing gas (paragraphs 16 and 29), and irradiating the

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substrate (paragraph 29) to thereby form an oxide film 21 on the substrate, but Murakawa fails to disclose expressly wherein irradiating the surface of a high-dielectric constant insulating film disposed on the substrate, to thereby form the oxide film at the interface between the high-dielectric constant insulating film and the substrate.

Referring to figures 1-2 and related text, Bloom discloses wherein forming a gate dielectric 20 on a substrate 10, which contains a silicon dioxide layer as an underlying layer and a silicon nitride layer as an insulating layer. The silicon dioxide layer is formed at the interface between the silicon nitride and the substrate (col. 3, lines 5-30), [Re claim 20] in an oxygen atmosphere of O₂ (col. 3, lines 20-25). The motivation stated in claim 1 also applies.

Referring to figure 1 and related text, Deboer discloses a high dielectric film 14 as an insulating film (page 2, paragraph 21), [Re claim 18] which includes HfO₂, Ta₂O₅, etc. (page 1, paragraph 9; page 2, paragraph 21). The motivation stated in claim 9 also applies.

20. [Re claims 46 and 53] The combined teaching of Murakawa, Bloom and Deboer discloses substantially the claimed limitations, as shown in claim 16. The motivations stated in claims 1 and 9 also apply. Murakawa also discloses forming a gate electrode 13 on the high-dielectric constant gate insulating film (see figs. 1a, 1b).

21. Murakawa discloses [Re claims 17 and 47] wherein the plasma is generated based on microwave via a plane antenna member (RLSA) having a plurality of slots (paragraph 24; see abstract).

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22. Murakawa discloses [Re claim 19] wherein the process gas comprises at least one rare gas selected from the group consisting of Kr, Ar, He and Xe (paragraph 19).

23. [Re claim 21] The combined teaching of Murakawa and Bloom fails to disclose expressly wherein further comprising annealing the substrate after the formation of the oxide film; and [Re claim 51] annealing the surface of the high-dielectric constant gate insulating film.

Deboer discloses a post-deposition anneals after formation of a dielectric film using O₂ as a source gas (page 2, paragraph 21). [Re claim 22] The post-deposition anneal is performed in an oxygen ambient (page 2, paragraph 21), and the oxygen source can be provided using O₂ (page 4, paragraph 34).

Since Bloom discloses the silicon dioxide is formed in an oxygen atmosphere of O₂ (col. 3, lines 20-25), so the post-deposition anneal may perform. The motivation stated in claim 13 also applies.

24. Deboer discloses [Re claim 23] wherein the annealing is conducted at a temperature of 500-1100°C (page 4, paragraph 34). In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

25. Murakawa discloses [Re claims 24 and 48] wherein the substrate is at a temperature from room temperature to 500°C (paragraphs 62 and 66). In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima

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facie case of obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

26. [Re claims 25 and 49] The combined teaching of Murakawa, Bloom and Deboer fails to disclose expressly wherein the oxide film is formed at a pressure of 3-500 Pa.

However, any variation in pressure in the present claim is obvious in light of the cited art, because the changes in pressure produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. *In re Aller, Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

27. Bloom discloses [Re claims 26 and 52] wherein the oxide film is a silicon oxide film (col. 3, lines 20-30), but Bloom fails to disclose expressly wherein the oxide film having a thickness of 6-12 Å.

However, any variation in the oxide film thickness in the present claim is obvious in light of the cited art, because the changes in the oxide film thickness produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. *In re Aller, Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

28. [Re claim 27] The combined teaching of Murakawa, Bloom and Deboer fails to disclose expressly wherein the plasma has an electron temperature of 0.5-2.0 eV.

However, any variation in electron temperature in the present claim is obvious in light of the cited art, because the changes in electron temperature produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. *In re Aller*, *Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

29. Murakawa discloses [Re claims 28 and 54] further comprising plasma nitriding the surface of the substrate before the formation of the high-dielectric constant insulating film (paragraphs 23-24).

30. Claims 29-39 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combined teaching of Murakawa, Bloom and Deboer, as applied above, and further in view of Ota (US Pat. 6436777).

31. [Re claim 29] The combined teaching of Murakawa, Bloom and Deboer discloses substantially the claimed limitations, as shown in claim 16. The motivations stated in claims 1 and 9 also apply. However, it fails to disclose expressly wherein the high dielectric film is a HfSiO film.

Ota discloses a HfSiO₂ film as a high dielectric constant material film (col. 8, line 55-col. 9, line 5).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use a HfSiO film, instead of using a HfO₂ film disclosed in Deboer,

because it would have been to obtain less reactive film than HfO_2 film at the interface with a gate electrode (Ota, col. 8, lines 25-30).

32. Murakawa discloses [Re claim 30] wherein the plasma is generated based on microwave via a plane antenna member (RLSA) having a plurality of slots (paragraph 24; see abstract).

33. Murakawa discloses [Re claim 31] wherein the oxygen atom-containing gas is O_2 gas and the process gas comprises at least one rare gas selected from the group consisting of Kr, Ar, He and Xe (paragraph 62).

34. [Re claim 32] The combined teaching of Murakawa and Bloom fails to disclose expressly wherein further comprising annealing the substrate after the formation of the oxide film.

Deboer discloses a post-deposition anneals after formation of a dielectric film using O_2 as a source gas (page 2, paragraph 21). [Re claim 33] The post-deposition anneal is performed in an oxygen ambient (page 2, paragraph 21), and the oxygen source can be provided using O_2 (page 4, paragraph 34).

Since Bloom discloses the silicon dioxide is formed in an oxygen atmosphere of O_2 (col. 3, lines 20-25), so the post-deposition anneal may perform. The motivation stated in claim 13 also applies.

35. Deboer discloses [Re claim 34] wherein the annealing is conducted at a temperature of 600-1100°C (page 4, paragraph 34). In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of

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obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

36. Murakawa discloses [Re claim 35] wherein the substrate is at a temperature from room temperature to 500°C (paragraphs 62 and 66). In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

37. [Re claim 36] The combined teaching of Murakawa, Bloom, Deboer and Ota fails to disclose expressly wherein the oxide film is formed at a pressure of 3-500 Pa.

However, any variation in pressure in the present claim is obvious in light of the cited art, because the changes in pressure produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. *In re Aller, Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

38. Bloom discloses [Re claim 37] wherein the oxide film is a silicon oxide film (col. 3, lines 20-30), but Bloom fails to disclose expressly wherein the oxide film having a thickness of 6-12 Å.

However, any variation in the oxide film thickness in the present claim is obvious in light of the cited art, because the changes in the oxide film thickness produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art

will only occur if the parameter variation produces an unexpected result. *In re Aller*, *Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

39. [Re claim 38] The combined teaching of Murakawa, Bloom, Deboer and Ota fails to disclose expressly wherein the plasma has an electron temperature of 0.5-2.0 eV.

However, any variation in electron temperature in the present claim is obvious in light of the cited art, because the changes in electron temperature produce no unexpected function. The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. *In re Aller*, *Lacey and Hall*, 105 USPQ 233, 235. *In re Reese* 129 USPQ 402, 406.

40. Murakawa discloses [Re claim 39] further comprising plasma nitriding the surface of the substrate before the formation of the HfSiO film (paragraphs 23-24 and 29).

41. Bloom discloses [Re claim 41] wherein further comprising washing the substrate before the formation of the HfSiO film (col. 3, lines 5-11).

Allowable Subject Matter

42. Claims 40 and 50 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: claim 40 recites the HfSiO film is formed by using tertiary ethoxy hafnium (TEOH: $\text{Hf}(\text{OC}_2\text{H}_5)_4$) and silane gas (SiH_4). Claim 50 recites nitriding the surface of the high-

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dielectric constant gate insulating film after the formation of the oxide film. These features in combination with the other elements of the base claims are neither disclosed nor suggested by the prior art of record.

43. Claims 42-44 are allowed.

The following is an examiner's statement of reasons for allowance: claim 42 recites irradiating the surface of the HfSiO film with the plasma to thereby form an oxide film at the interface between the HfSiO film and the substrate, and nitriding the surface of the HfSiO film. These features in combination with the other elements of the claim are neither disclosed nor suggested by the prior art of record.

Claims 43-44 depend from claim 42, so they are allowed for the same reason.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Cheung Lee whose telephone number is 571-272-5977. The examiner can normally be reached on Monday through Friday from 8:30AM to 5:00 PM.

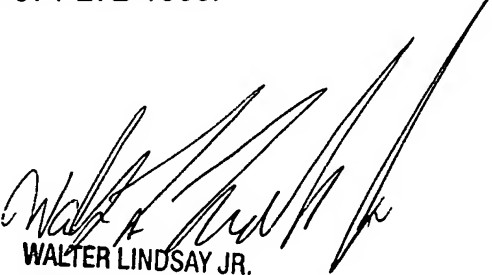
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on 571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Cheung Lee

March 17, 2007



WALTER LINDSAY JR.
PRIMARY EXAMINER